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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT MERCURY
(MODM PROJECT)

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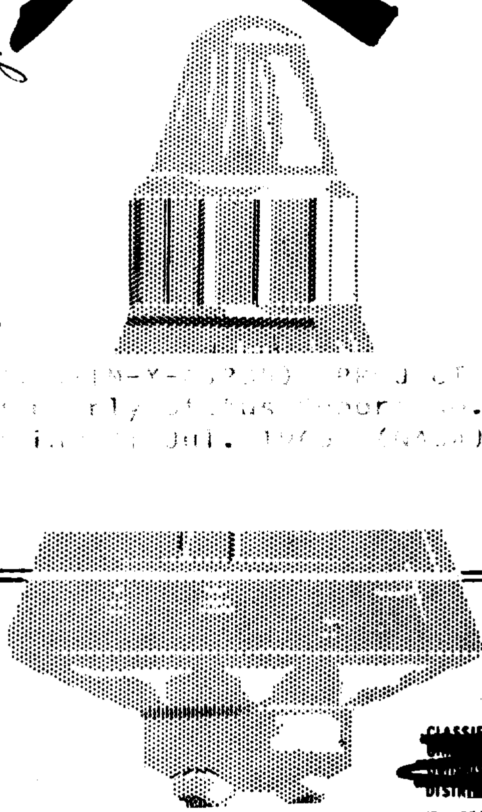
QUARTERLY STATUS REPORT
NO. 19
FOR PERIOD ENDING
JULY 31, 1963



MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT MERCURY

QUARTERLY STATUS REPORT NO. 19

(FINAL)

FOR

PERIOD ENDING JULY 31, 1963

By Manned Spacecraft Center

INTRODUCTION

This is the nineteenth and final in a series of reports on the status of the NASA manned-spacecraft project, Project Mercury, and the third covering the Manned One-Day Mission (MODM) Project (Mercury Spacecraft). The previous report covered the MODM Project's progress through June 30, 1963.

The successful flight of Spacecraft No. 20 with Astronaut L. G. Cooper at the capsule controls was completed on May 16, 1963.

The preparation of Spacecraft No. 15B for the MA-10 mission, which was scheduled as a backup to the MA-9 mission, has been canceled and the termination of the MODM is in progress.

MANUFACTURING AND DELIVERY

The manufacturing and delivery effort of the Project Mercury and Manned One-Day Mission (MODM) spacecraft, including disposition after flight testing, is discussed in this section. Excluded from this discussion are those spacecraft that were no longer being used for a mission or test program during this period. However, figure 1 shows the use and location of all production spacecraft. Figure 2 shows the launch dates of the MA-6, MA-7, MA-8, and MA-9 missions and the date of termination for the MA-10 mission.

Spacecraft No. 5 (MR-2) was used for the net couch qualification drop tests and is now in storage at MSC, Houston, Texas.

Spacecraft No. 10 (Project Orbit) was used for the MODM Spacecraft Environmental Control System Evaluation and Testing Program and is now in storage at MSC, Houston, Texas.

Spacecraft No. 14B (LJ-5) was used for explosive-hatch tests and is now in storage at MSC, Houston, Texas.

Spacecraft 15B (MA-10) was placed in storage at Cape Canaveral, Florida after program termination.

Spacecraft No. 18 (MA-7) was used for the MODM egress training program and is at MSC, Houston, Texas. Preparations are being made to convert this spacecraft back to the MA-7 flight configuration for display.

Spacecraft 20 (MA-9) was launched at 08:04 e.s.t. on May 15, 1963 for a Manned One-Day Mission. The spacecraft "Faith 7" and pilot L. Gordon Cooper, Jr. were recovered in the planned recovery area on May 16, 1963 after over 34 hours of space flight. The spacecraft has completed postlaunch testing and analysis at Cape Canaveral and is presently at McDonnell Aircraft Corporation, St. Louis, Mo., being prepared for display.

PROGRAM TERMINATION

The following actions are in progress or have been completed in regards to contract termination.

a. Notification of partial termination was given to the Contractor, McDonnell Aircraft Corporation, on June 13, 1963. This termination left certain items such as the MA-9 postlaunch evaluation in progress.

b. USAF Space Systems Division (SSD) was notified that the remaining Atlas launch vehicles were no longer required under the Manned One-Day Mission Program.

c. McDonnell Aircraft Corporation is currently in the process of reviewing excess Mercury equipment for possible use on the Gemini Programs. McDonnell Aircraft Corporation is also submitting equipment on excess forms for review by Manned Spacecraft Center (MSC) and initiation of final dispositioning action.

d. McDonnell Aircraft Corporation is also currently preparing a termination proposal which is expected to be negotiated during the month of September 1963.

The Test and Operational Support Procurement Office, formerly the Mercury Procurement Office, is conducting the major portion of the termination effort with technical assistance from the Mercury Project as required.

MAJOR SYSTEMS-SPACECRAFT

The current status of the MODM Project spacecraft, plus major systems information, is given in this section.

WEIGHTS

Table I compares the weights of the spacecraft flown in the MA-6, MA-7, MA-8, and MA-9 missions with that of Spacecraft No. 15B which was being prepared for the MA-10 mission. Figure 3 shows the actual orbit weight of Spacecraft Nos. 13, 16, 18, and 20 and the preflight orbit weight trends of Spacecraft Nos. 16, 15B, 18, and 20.

Spacecraft No. 20

The actual orbit weight of Spacecraft No. 20, as of launch date, was 3,035 pounds. The actual orbit weight of Spacecraft No. 20 exceeded the planned upper weight limit of 3,025 pounds by 10 pounds.

Spacecraft 15B

The calculated orbit weight of spacecraft No. 15B, less experiments, was 3,223 pounds at the time of program cancellation. Based on previous Mercury mission weight growth experience the orbit weight of the spacecraft on the scheduled launch date would have been approximately 3,284 pounds. The large increase in the orbit weight of spacecraft No. 15B was due to the modifications made for mission flexibility.

In addition to the spacecraft changes listed above, a Minitrack beacon system was to be installed in the spacecraft adapter section and this would have increased the launch gross weight by approximately 10 pounds.

STRUCTURES

Spacecraft No. 20

No structural changes were made to Spacecraft No. 20 from the date of the last report until launch.

Spacecraft 15B

The report on the structural interface panel including an analysis of the Minitrack beacon installation planned for spacecraft No. 15B was received.

ROCKETS AND PYROTECHNICS

Rocket Motors

No changes were made to the rocket motors during the time period covered by this report.

Spacecraft No. 20.- The inflight performance of the rocket motors in the MA-9 mission was satisfactory in all respects.

Spacecraft No. 15B.- No changes were planned in the rocket motor system for succeeding missions.

Pyrotechnics

The pyrotechnic system philosophy remained unchanged; however, changes in quality control procedures were made and are described in the following paragraphs.

Spacecraft No. 20.- All pyrotechnics, except four spacecraft umbilical disconnect devices, operated satisfactorily on the MA-9 flight. These four unsatisfactory devices apparently did not contain the proper amount of explosive, since it was found in postflight tests that like units from the same batch did not contain the proper amount of explosive charge. The substandard batch was found to have been manufactured for ground tests but were mislabeled and mixed with flight batches.

Spacecraft No. 15B.- As a result of the umbilical disconnect troubles described above, procedures were immediately implemented to provide assurance that all pyrotechnic devices were ready for succeeding flights by requiring properly certified documents and appropriate tests.

PARACHUTE AND LANDING SYSTEMS

The parachute and landing systems performed normally and properly during the MA-9 mission on spacecraft no. 20. No changes were planned for succeeding missions.

ENVIRONMENTAL CONTROL SYSTEM

A wicking-type condensate separator, designed, developed, and fabricated by MSC, Houston, was installed in the inlet side of the astronaut suit-circuit supply hose for the MA-9 mission. This separator was installed to improve the water-removing efficiency of the suit-circuit system. The action of this separator is controlled by a clamp-type valve located on the outlet hose to the condensate-transfer system. The condensate separator was not utilized during a major portion of the MA-9 mission because of a hose-fitting malfunction in the condensate-transfer system. However, the condensate separator, while in operation, did function properly and provided the astronaut with a more comfortable environment.

During the MA-9 mission, the condensate-transfer system failed because of a restriction of flow in the outlet transfer line. As a result of these problems, the condensate-collection system was redesigned in spacecraft no. 15B to incorporate the wicking-type condensate separator with automatic fail-safe storage capability. The urine-transfer system of spacecraft no. 15B, because of its similarity to the faulty condensate-transfer system in spacecraft no. 20, was redesigned to incorporate a six-way selector valve. This valve would have provided astronaut selection of a direct path to any one of five urine storage containers, located beneath the couch, from the suit urine collection bag without disconnecting any lines or fittings. At termination of the Mercury Program, the selector valve had not undergone qualification tests.

A temperature-sensitive automatic coolant-control system was also designed for spacecraft no. 15B. The redesigned coolant-control system for spacecraft no. 15B utilized the warning tone circuitry which sensed heat-exchanger dome temperature to close a normally open solenoid valve in the coolant-supply line to prevent heat-exchanger freeze-up.

PRESSURE SUIT

The pressure suit being developed for the MA-10 mission was undergoing qualification testing at the time of the program termination.

ATTITUDE CONTROL SYSTEM

No changes were made to the configuration of the Attitude Control System (ACS) for spacecraft nos. 20 and 15B during this reporting period.

Two anomalies, involving the ACS during the MA-9 mission, were premature actuation of the reentry 0.05g sequence and disablement of the Automatic Stabilization and Control System (ASCS) a-c bus which occurred at 28:34:34 hours and 33:02:45 hours, ground elapsed time, respectively. Post-mission investigation revealed that both malfunctions were caused by low resistance short circuits in two of the amplifier-calibrator (amp-cal) electrical connectors. All available evidence indicates that the short circuits were caused by condensate water from the Environmental Control System which saturated the cabin atmosphere and eventually seeped into the amp-cal electrical connectors. The malfunctions resulted in loss of spacecraft automatic control for retrograde and reentry, thus necessitating manual control of the spacecraft during these mission phases.

With the exception of the disabling caused by the anomalies noted above, the ACS performed satisfactorily during the MA-9 mission. For succeeding missions, it was planned to seal the amp-cal against moisture.

REACTION CONTROL SYSTEM

The Reaction Control System performed satisfactorily during the MA-9 mission. Fuel management was excellent with approximately 7 pounds of manual fuel and 21 pounds of automatic fuel being jettisoned after reentry.

Spacecraft No. 15B had been modified for mission flexibility as outlined in previous reports, and was undergoing preflight (SEDR-73) tests when the program was terminated.

PILOT SUPPORT AND RESTRAINT

Spacecraft No. 20

The support and restraint system for spacecraft no. 20 was the same as described in the previous status report, and performed satisfactorily.

Spacecraft No. 15B

The support and restraint system for spacecraft no. 15B was to be the net couch type described in previous status reports. Qualification of the net couch support system had been satisfactorily completed. Two net couch frames were delivered to the Cape and fitted to the spacecraft.

CREW SPACE LAYOUT, CONTROLS AND DISPLAYS

No changes were made to the instrument panel of spacecraft no. 20 during this reporting period.

The following differences shown in figure 4, existed between spacecrafts no. 15B and no. 20 at program termination.

a. Handles were provided to turn on water from two 39-pound tanks.

b. A coolant-quantity indicator was added to provide the astronaut with a means of monitoring the amount of coolant remaining.

c. A toggle switch which allowed the astronaut to select orbit or reentry pitch attitude was removed.

d. An ampere-hour meter to indicate percent of electrical power remaining was added.

e. Temperature indicators for the battery and water tank mounted on the retropackage were added. Temperature readings that were deleted include: four thrusters, retrorocket, cabin heat exchanger steam outlet, and auxiliary hydrogen peroxide tank.

f. A switch for Reentry Communications Experiment was added.

g. Switches to deploy balloon used for drag experiment were deleted.

ONBOARD COMMUNICATIONS

Spacecraft No. 20

HF Whip Antenna.- As discussed in the last Status Report, erection of the HF whip antenna was performed by nitrogen gas pressure on the MA-9 mission. All preflight tests of the system were satisfactory.

After the landing of spacecraft no. 20, the whip antenna was deployed and stations received the HF rescue signals satisfactorily. The HF voice transceiver was not used after landing since recovery ships were in the immediate vicinity and UHF communications were adequate.

Television System.- Development testing of the slow-scan TV system continued until shortly before lunch. Because of the position of the camera near the pilot's right side, coverage of the pilot was expected to be restricted.

During exit flight of MA-9, vibrations near the maximum dynamic pressure region resulted in blotting of the picture displayed on the ground TV monitor. Otherwise the pictures received during exit were fair. After reaching orbital altitudes where the sunlight is not diffused by dust particles in the atmosphere, light levels in the spacecraft were lower than expected which resulted in poor quality pictures. When the sunlight shown in through the spacecraft window, the contrast between the sunlit and darkened areas in the spacecraft was too high for satisfactory pictures.

All TV equipment in the MA-9 flight functioned without any component failures. During the MA-9 flight, switching of telemetry data from its normal transmitter to the TV transmitter was accomplished satisfactorily, and the telemetry data transmitted by way of the TV transmitter was of good quality.

Other Communications Equipment.- All other communications equipment performed satisfactorily during the MA-9 mission.

Spacecraft No. 15B

The TV system was not planned for spacecraft no. 15B. Otherwise, the communications equipment was the same as in spacecraft no. 20.

Minitrack Beacon System.- A Minitrack beacon system was planned for installation in the launch vehicle for the MA-10 mission. The Minitrack beacon antenna, which is a Gemini unfurlable antenna modified for use at a lower frequency by incorporation of a longer radiation element, passed the Mercury random vibration qualification test after a minor redesign of the latching mechanism. Radiation pattern tests conducted on a model-antenna range show the patterns to be typical of a turnstile antenna. The Goddard Space Flight Center is currently completing the qualification of the government furnished beacon transmitter and power supply for possible future use in high-level vibration environments. A description of the beacon system, acceptance tests, installation procedures, schematics, and antenna patterns can be found in the McDonnell Aircraft Corporation report SEDR 238.

ONBOARD INSTRUMENTS AND RECORDERS

During the MA-9 flight the tape recorder performed normally. However, a failure of the automatic programer for the tape recorder occurred and is discussed in a later section.

Spacecraft No. 20

Carbon Dioxide Sensor.- The carbon-dioxide partial-pressure sensor operated satisfactorily during the entire MA-9 flight. A postflight calibration of the sensor was in agreement with the preflight calibration.

Oxygen sensor.- The oxygen partial-pressure sensor appears to have operated satisfactorily during the MA-9 flight. The oxygen partial-pressure readings were lower than the total cabin pressure readings primarily because of the water vapor pressure in the cabin. Because the charge life of the sensor expired before the spacecraft was returned to the Cape, a postflight calibration could not be made.

Programer.- As reported in the last status report, erroneous R and Z calibrations were initiated during preflight checkouts (SEDR 77). The problem was later traced to the programer's sensitivity to power supply transients. Laboratory tests indicated that the addition of a load resistor to the command input side of the R and Z calibration circuitry would solve the problem. Also, as a precaution, an astronaut-operated manual override switch which would interrupt the automatic programing of the R and Z calibrations was added to spacecraft nos. 20 and 15.

Several erroneous R and Z calibrations were received during the automatic mode of operation during the first two orbital passes in the MA-9 flight. It is believed that one or more voltage transients caused the programer to cycle improperly. The astronaut turned the R and Z calibration switch off near the end of the second orbital pass; he turned it on soon after the beginning of the third pass, after which the R and Z calibrations were normal. Vendor investigation of R and Z calibration anomalies is still in progress.

The programer section which controlled the automatic programing of the recorder failed during the MA-9 mission after about 12 hours of flight. Postflight analysis indicated that this problem was a result of a broken shaft at a bearing support plate which caused the gears to bind.

Spacecraft No. 15B

Onboard tape recorder.- The development of a longer duration recorder for spacecraft no. 15 was not completed at program termination. This new 8-track-head recorder was to operate at 15/16 ips and be reversible, thereby recording four tracks in each direction. The qualification test unit had undergone 27 hours of high temperature testing. One production recorder has been completed except for cleanup and final inspection. The second production recorder was partially completed.

Carbon dioxide sensor.- The same type of carbon dioxide partial-pressure sensor utilized on MA-9 was planned for spacecraft no. 15B.

Oxygen sensor.- It was planned to install a sealed-type oxygen partial-pressure sensor in spacecraft no. 15B instead of the refurbishable type that was installed in spacecraft no. 20.

Biomedical tape recorder.- A biomedical tape recorder had been qualified and was ready for spacecraft no. 15B when the program was terminated. There are two flight units, one prototype unit, and one qualification unit on hand for disposition.

ELECTRICAL AND SEQUENTIAL SYSTEM

No changes were made to the configuration of the Electrical and Sequential System for spacecraft nos. 20 and 15B during this reporting period.

The electrical power systems performed satisfactorily during the MA-9 mission. The early reports that the main and standby inverters had failed were later proven erroneous. The inverters were designed not to operate into a short circuit load such as was present in the late hours of the mission. The inverters operated satisfactorily during postmission tests conducted at the Cape. The Sequential System performed satisfactorily during the MA-9 mission, with the exception of that portion of the Sequential System associated with the amp-cal 0.05g circuitry that was disabled by the shorted electrical connector.

SYSTEMS TESTS

Vibration tests of spacecraft no. 15B retropack were begun during this reporting period. However, the Mercury Program was concluded prior to their completion and the tests were cancelled.

EXPERIMENTS

MA-9 MISSION

The experiments which were planned for MA-9 were described briefly in the 17th Quarterly Status Report. A detailed summary of the results of these experiments may be found in the Postlaunch Memorandum Report for Mercury-Atlas No. 9, Part I - Mission Analysis. The following is a brief summary of these results.

a. Flashing beacon

The beacon was deployed according to the Flight Plan about 15 minutes prior to sunset on the third orbit. After deployment, the Astronaut yawed the spacecraft 180° and tried to acquire the light visually but was not able to do so at that time.

The light was first acquired prior to sunset on the fourth orbit, and the Astronaut successfully tracked and reacquired the beacon a number of times on the fourth and fifth orbits. He made several estimates of the light intensity and range during the experiment. In general, it was found that the flash of the light made it easily distinguished from the stars. At night, the beacon's intensity appeared to be adequate for acquisition up to distances of 8 nautical miles.

b. Balloon drag and visibility

The inflatable balloon was to be deployed on the sixth orbit. The Astronaut tried to deploy the balloon twice on this orbit but the mechanism for release failed to actuate. The most probable cause for the failure was an electrical malfunction in that portion of the circuitry in the antenna canister where the balloon was stored. The antenna canister was not recovered; therefore, this malfunction cannot be resolved.

c. Electron - flux measurements

Measurements were made of the electron flux incident on the spacecraft by means of Geiger Mueller counters mounted externally on the retropackage. Appreciable count rates were obtained on the 7th orbit, but, in general, the count rates were lower than anticipated. Radiation measurements made on the inside of the spacecraft by means of an ion chamber and film badges were well below the physiologically harmful level. Most of the radiation data from the mission is now undergoing a long-term, detailed analysis.

d. Horizon definition photography

The Astronaut took a set of 11 photographs which included two of each of the quadrants of the earth limb and three of the setting moon and the earth limb. A planned series of photographs of the earth's horizon throughout the daylight portion of one orbit was not performed because of the spacecraft control-system malfunction which occurred late in the mission. Because of some difficulty in loading the camera back prior to the flight, some background "light-struck" damage was incurred by the film. A careful initial inspection of the photographs indicates that six of the eight quadrantal exposures and two of the three moon-set pictures are usable for quantitative study.

e. Dim-light photography was performed on the night side of the 16th orbit with all cabin lights out. Just prior to sunset, the spacecraft was oriented into the plane of the ecliptic and flown on automatic attitude control throughout the zodiacal-light photography period. This sequence was started just after sunset and several photographs were taken with exposure durations from 1 to 30 seconds. A total of 17 exposures were made of the zodiacal light. During the night period, an additional 15 photographs were made of the horizon and airglow layer.

f. Infrared weather photography

The Astronaut took a series of 16 infrared photographs of the southern part of the United States and the southern part of Africa during the 17th and 18th orbits. The U. S. Weather Bureau is analyzing these photographs for the purpose of measuring the contrast of terrain features and clouds on infrared film and making comparisons of these photographs with similar photographs taken on film in the visible wavelengths.

g. Ground light observation

A ground light located at Bloemfontein, Republic of South Africa, was seen by the Astronaut as the spacecraft passed this point on the sixth orbit. The Astronaut reported the light to be of sufficient brightness to be used as a navigation landmark if adequate sighting information were to be made available. He stated that the distinctive U-shaped light pattern of the town was very helpful in identifying the light, that a flashing light would have been much more distinctive, and that a pattern of flashing lights would have been even more distinguishable.

h. Cabin temperature evaluation

At approximately 06:22 elapsed time, the Astronaut began the cabin temperature evaluation by turning off the cabin fan and coolant-water flow to the cabin heat exchanger. At this time the cabin temperature was slowly oscillating between 90° and 95° F. The maximum cabin temperature observed during the period of evaluation was 103° F, which occurred during a powered-up condition, and the minimum temperature was 84° F, which occurred during an extended period while the spacecraft was powered-down. The cabin temperature during the experiment oscillated approximately ±5° F, and the temperature trend was influenced by the cycling of electrical power and sun-light heat loads. The average cabin temperature during the evaluation was 90° F. At 32:05 the Astronaut terminated the evaluation and turned on the cabin cooling system, as planned, in preparation for reentry. The cooling system responded rapidly, as evidenced by a drop in the cabin-heat-exchanger outlet temperature.

i. HF antenna evaluation

The Astronaut conducted a HF voice transmitter-receiver test utilizing the HF dipole antenna. The test was initiated near the end of the 19th pass when the spacecraft was just north of Panama. The stations that reported receiving the HF signals were Mercury Control Center (MCC); Hangar S; Point Arguello, California (CAL); Guaymas, Mexico (GYM); Corpus Christi, Texas (TEX); Grand Turk Island in the Atlantic Missile Range (GBI); White Sands, New Mexico; and Houston, Texas. The spacecraft attitude appeared to have had little effect on signal recption; however, the data obtained during this test are presently being evaluated.

j. Window attenuation evaluation

This evaluation was not performed because of its low priority and because of the lack of an opportune time to conduct the evaluation.

LAUNCH VEHICLE

ATLAS PERFORMANCE

The actual Atlas performance for the MA-9 mission was slightly higher than the preflight predictions. This was the first Mercury/Atlas launch vehicle to lift off with the full propellant load (no additional hold-down or off-loading). The Atlas performance planned for the MA-10 mission was to be the same as for the MA-9 mission.

GUIDANCE

The launch-vehicle guidance system for the MA-9 mission performed well and placed the Mercury spacecraft into a near perfect orbit. The ground tracking radar showed a low noise level.

The guidance system planned for the MA-10 mission was to be the same as that for the MA-9 mission.

ATLAS ABORT SENSING

The abort sensing for the MA-9 mission performed well with no abnormalities. No changes were planned for the MA-10 mission.

CREW TRAINING

The extensive preflight preparations by the MA-9 flight crew (Major Cooper and Commander Shepard) were concluded during the first

2 weeks of this reporting period. The following training activities were accomplished during this terminal period.

a. Systems and Operations Evaluation.- On May 1, 1963, the MA-9 flight crew completed a written questionnaire designed to evaluate their knowledge of all facets of the mission. This included understanding of the spacecraft systems, missions operations - both normal and abnormal, mission rules, procedures, and operational and experimental inflight activities.

b. Mercury Procedures Trainer.- The prime pilot spent four sessions on the trainer brushing up on final normal and abnormal operational procedures, attitude control maneuvers, rehearsing finalized flight plan activities, manipulating onboard equipment, and participating in network and launch abort simulations.

c. Aircraft Flying.- Both pilots continued to fly jet-type aircraft almost to launch date. Major Cooper flew the F-102A on May 10, 1963, 5 days prior to the MA-9 launch date.

d. Spacecraft Testing.- The MA-9 flight crew spent many hours participating in the final testing of the spacecraft and booster systems on the launch pad, accumulating approximately 25 hours during the last 2 weeks prior to flight.

Prior to and during the flight, the other Mercury Astronauts supported the MA-9 mission as remote site commanders and capsule communicators. Subsequent to the pilot postflight debriefings, the decision was made to cancel the MA-10 mission, thus terminating further Mercury training.

OPERATIONS

TRACKING AND GROUND INSTRUMENTATION

All network planning for Mercury has been terminated and modifications during this reporting period were as identified in the preceding report. However, evaluations of certain of these modifications have been accomplished and are described in the following paragraphs:

a. Automatic Voice Relay.- All the voice relay systems were exercised and results were relatively good. The remoting technique is planned for use in the Gemini and Apollo missions.

b. Teletype Printers at the MCC and Remote Sites.- A teletype model 28 and an experimental Mite unit were installed at MCC adjacent to the Procedures Console. Model 28 printers were installed in the Capsule Communicator Console at California and Hawaii stations.

The teletype unit at MCC, as installed, was unsatisfactory because of noise in operation, but the Mite was entirely satisfactory in all respects. Remote site installations were also acceptable.

Present plans are to install teleprinters at operational positions in the IMCC and at all remote sites.

c. HF Propagation, Spacecraft-to-Ground.- Preliminary evaluation of the HF spacecraft-to-ground communication tests of MA-9, by using vertically polarized antennas, indicates some advantage is obtained with this arrangement.

d. AN/FPS-16 Radars at East Island.- Status Report 18 cited the proposed use of the East Island radar for MA-9. The radar tracked on three orbital passes with good data. Future use of this radar will be considered if required.

e. Tracking Ships.- The Twin Falls Victory C-band Tracking Ship was used for operational evaluation during MA-9. Good data were obtained during orbits 4, 7, 15, 16, and poor data were received on orbit 2. The RTK C-band ship was used for reentry. Good track was obtained on orbits 20, 21; reentry track on orbit 22 was poor because of the low elevation angle. The ship tracking capability is being considered for future programs.

f. ECG Real Time Transmission from CAL, ASC, and ANT.- The ECG transmissions during MA-9 were, in general, very successful and future ECG remoting can be useful. A detailed analysis is being made for future planning.

LAUNCH OPERATIONS

Spacecraft Preparation

Spacecraft No. 20 (MA-9).- All spacecraft no. 20 postflight tests have been completed.

Spacecraft No. 15B has been prepared for storage.

Coordination

General coordination to close out the Mercury program is underway.

Cape and Patrick Facilities

Complex 14.- McDonnell Aircraft Corporation deactivation of Complex 14 is in progress. Approximately 25 percent of blockhouse equipment has been removed.

Mission Control Center.- Building modification of the Mission Control Center to acquire Gemini capability is 89 percent complete. The Corps of Engineers estimates completion on August 15, 1963.

FLIGHT OPERATIONS

Flight-Control Operations

A two-team concept for flight-control and mission support was implemented to insure effective support to the long-duration MA-9 mission. All flight-control support functions at both the MCC and remote sites were performed in a highly satisfactory manner by both teams.

Training

Two days of launch simulations and 4 days of network simulations were conducted prior to the MA-9 mission. These simulations proved invaluable, particularly considering the long-time gap between MA-8 and MA-9. The quality of the MA-9 simulations was significantly improved over that of previous Mercury simulations.

All training and simulation efforts in preparation for MA-10 ceased with the termination of Project Mercury.

RECOVERY

MA-9 Mission

The MA-9 recovery operations were supported with 12 ships and 26 aircraft available for recovery in the Atlantic planned areas, and 11 ships and 18 aircraft in the Pacific areas. In addition, a large number of Air Rescue Service aircraft were deployed to advance staging bases, where they remained on strip alert during the flight for a possible contingency landing. All forces were on station at launch time and moved to planned positions as the mission progressed. Weather conditions were favorable for spacecraft location and retrieval in all planned and contingency areas throughout the mission.

Upon completion of the planned mission, the retrorockets were fired to land in the primary recovery area 22-1. Retrorocket firing time and the expected landing positions were passed to the recovery units in the area. The USS KEARSARGE, the aircraft carrier positioned at the center of the area, reported radar contact with the spacecraft at a range of approximately 180 nautical miles and held contact until shortly before spacecraft landing. A "sonic boom," similar to that heard during the MA-8 reentry, was detected by the recovery ship personnel, followed by visual contact with the spacecraft as it descended on the main parachute at an altitude of about 8,000 feet. The spacecraft landed about 4.4 miles uprange of the KEARSARGE.

Helicopters were launched from the KEARSARGE and were in position to deploy swimmers when the spacecraft landed. Approximately 4 minutes after landing, the swimmers installed an auxiliary flotation collar around the spacecraft, and the Astronaut indicated that he would remain in the spacecraft and await retrieval by the recovery ship. The spacecraft was brought aboard ship, and the Astronaut egressed from it only 48 minutes after landing.

Following recovery, spacecraft data were removed and flown to Cape Canaveral. After completion of the 48-hour astronaut debriefing, the Astronaut and spacecraft were disembarked at Hawaii for return to Cape Canaveral.

Post-Mission.- All recovery data have been analyzed, and the final reports completed. Special recovery equipment provided to the DOD support units by NASA has been inventoried, and the equipment determined to be reusable in other programs is being returned to NASA Manned Spacecraft Center. The remaining equipment will be disposed of in the field.

RELIABILITY AND FLIGHT SAFETY

LAUNCH VEHICLE INSPECTION - FACTORY

No Atlas launch vehicles were inspected for configuration completeness during this period.

Preflight Flight Safety Review at AMR

A spacecraft no. 20 Review Meeting was held on May 9, 1963. All systems were approved for flight. An Atlas 130D Launch Vehicle Review Meeting was held on May 11, 1963. All systems were approved for flight, pending investigation of a ground equipment fuse anomaly. The Mission Review Meeting was held on May 11, 1963. The network reported trouble with Bermuda tracking. The Launch Vehicle Status Meeting and Flight Safety Review Board meetings were held on May 13, 1963. All problems were reported resolved and the spacecraft and launch vehicle were approved for flight. On May 14, 1963, the countdown was terminated because of Bermuda radar problems. On May 15, 1963, the MA-9 mission was successfully launched and on May 16, 1963, was successfully completed.

FLIGHT TEST PROGRAM

ATLAS FLIGHT MA-9

The MA-9 mission was successful in nearly every respect. The planned launch time of 8:00 a.m. e.s.t. on May 14, 1963, was postponed for 1 day because of intermittent digital data in both the azimuth and range channels of the C-band radar at Bermuda. Prior to postponement, the countdown had proceeded as planned until T-60 minutes, when an unscheduled hold of 2 hours and 9 minutes became necessary because of a fuel-pump failure in the diesel engine on the gantry transfer table. After this hold, the countdown was continued until T-13 minutes when the flight was postponed because of the radar problem. The launch operation on May 15, 1963, was the most efficient conducted to date. Four minutes of unplanned hold time were required to evaluate an external RF interference problem at the guidance control rate station. Weather conditions at the launch site and in the primary landing area were satisfactory. Lift-off occurred at approximately 8:04 a.m. e.s.t. on May 15, 1963, 2 hours and 31 minutes after the Astronaut entered the spacecraft.

Launch-vehicle performance was excellent, and the trajectory parameters displayed at the Mercury Control Center indicated a "go" condition at insertion. A near-perfect orbit was attained, with deviations from planned postposigrade values of space-fixed flight-path angle and velocity of 0.0037° and -1.4 ft/sec, respectively. Both the perigee and apogee of the initial orbit differed from the planned values of 87 and 144 nautical miles by 0.2 nautical mile. The decay in perigee and apogee after nearly 22 orbital passes was 1.6 and 7.1 nautical miles, respectively.

Spacecraft separation from the launch vehicle was normal and the planned manual turnaround was well executed by the pilot. The performance of the spacecraft systems was excellent for the first 18 orbital passes with the exception that the automatic section of the programer failed at 12:18:19 g.e.t. In addition, several minor problems were encountered with the R and Z calibrations, the drinking-water valve, and the condensate transfer system. Upon contacting Hawaii on the 19th orbital pass, the pilot reported that the 0.05g warning light had come on. Systems checks by the Astronaut revealed that the amplifier-calibrator was in the 0.05g configuration and that the ASCS could be used only during reentry. However, planned use of the ASCS for reentry was abandoned at about 33:07:00 g.e.t. when neither the main nor the standby 250 v-amp inverters would supply electrical power to the ASCS bus. The pilot manually initiated the required retrofire and reentry events. He controlled the spacecraft attitudes during retrofire by utilizing the manual proportional system. Because of the ASCS failure, the pilot was also required to conduct the reentry maneuver manually, and he elected to use both the manual proportional and fly-by-wire modes during this phase.

The pilot's performance throughout the mission was excellent, and he adhered closely to the flight plan until the ASCS problems occurred. The pilot had no difficulty in sleeping during the mission, although he woke up several times during the planned rest period and found it necessary to reestablish a comfortable suit temperature. He did not eat and drink as much as was desirable, and he has since commented on the difficulty of performing these functions with the devices that were available to him. All but two of the inflight experiments planned for the mission were performed (see experiments section).

The pilot's control of the spacecraft during retrofire and reentry was excellent and resulted in a landing only 4.4 nautical miles from the prime recovery ship, the aircraft carrier U.S.S. Kearsarge. Visual contact was made from the carrier after deployment of the main parachute. The recovery helicopters reached the spacecraft before impact and circled it during its descent. Swimmers were deployed from the helicopters and they immediately attached a flotation collar to the spacecraft. The pilot remained in the spacecraft until it was hoisted aboard the carrier, the hatch had been blown, and the doctors had given him a preliminary examination. The pilot egressed from the spacecraft in good condition 40 minutes after landing. A postflight physical examination conducted onboard the recovery ship revealed no evidence of significant physiological anomalies directly attributable to the space flight. The pilot demonstrated an orthostatic rise in heart rate and fall in blood pressure which was more pronounced than that detected after the MA-8 flight. Although this condition is not an inflight hazard, the implications of this hemodynamic response on return to 1g conditions will have to be given very serious consideration for longer missions.

Support activities from all ground elements, including flight control, Mercury network, and recovery, were excellent and contributed greatly to the successful accomplishment of the mission.

Postflight examination of the spacecraft, evaluation of the data collected during the mission, and detailed systems tests have determined the most likely causes of the major problems. Considerable information regarding man's capabilities to perform his assigned tasks during extended periods of time in the space environment has been obtained. Evaluation of the overall mission indicates that a high degree of success was obtained and confirms the accomplishment of all mission objectives.

PROGRAM ANALYSIS AND EVALUATION

At the beginning of the period covered by this report, the launch of the first MODM (MA-9, S/C 20) was indicated to be on schedule. The MA-9 mission was delayed 1 day because of tracking radar difficulties and was launched successfully May 15, 1963. See figure 5 for a complete PERT trend and summary chart for the first MODM covering the period from the first implementation of PERT on the project to the launch of MA-9.

During the final weeks preceding the launch of MA-9, no PERT Computer runs were made because the small number of remaining activities made manual calculations more practical.

Progress on the second MODM (MA-10, S/C 15B) was monitored using PERT until June 12, 1963 when the decision was made to terminate the Mercury project.

TABLE I.- WEIGHT STATUS OF MERCURY SPACECRAFT

Description	Established limit	MA-6 S/C 13	MA-7 S/C 18	MA-8 S/C 16	MA-9 MODM S/C 20	MA-10 MODM S/C 15B
Gross weight, launch, pounds		4267	4249	4325	4320	4591
Orbit weight, after posifire, pounds	3025	2989	2979	3029	3029	3276
End of reentry weight, pounds		2642	2632	2711	2637	2682
Flotation weight, pounds		2414	2393	2441	2387	2422
Abort reentry weight, pounds		2725	2715	2763	2753	2799
Flotation c. g. (Z station)		119.81	120.03	119.63	119.75	119.54

[redacted]

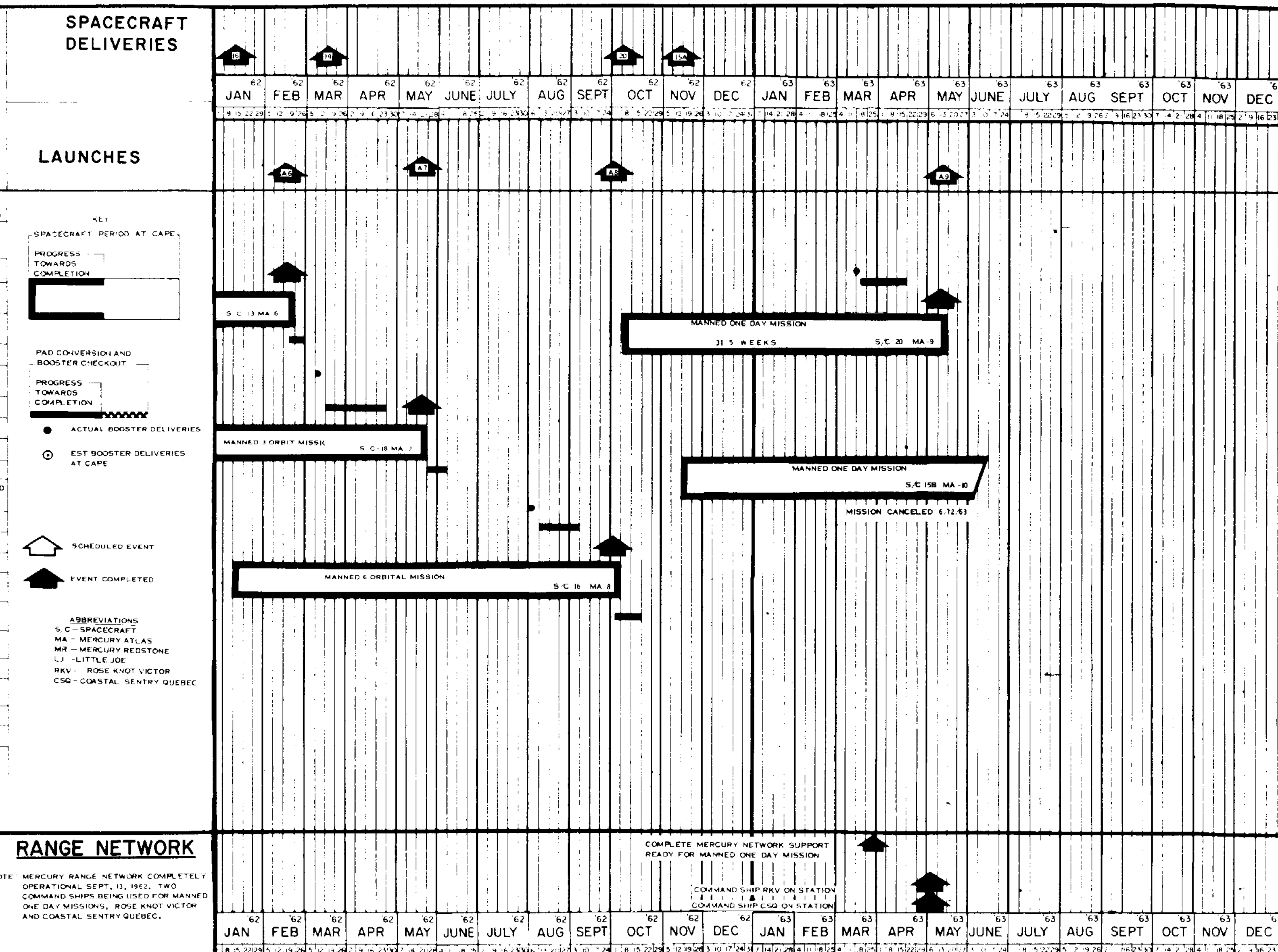
SPACECRAFT	ASSIGNMENT	PRESENT STATUS
NO. 1	BEACH ABORT - ADAPTED TO SLED TEST	TURNED OVER TO PAO IN HOUSTON PERMANENTLY TO BE USED AS DISPLAY
NO. 2	MR-I BALLISTIC UNMANNED MISSION, RCS TEST BED AT MAC	TURNED OVER TO PAO IN HOUSTON PERMANENTLY TO BE USED AS DISPLAY
NO. 3	LITTLE JOE 5	LOST ON LAUNCH, SPACECRAFT DID NOT SEPARATE FROM LAUNCH VEHICLE
NO. 4	MA-I	LOST ON LAUNCH, LAUNCH VEHICLE STRUCTURE FAILURE AFTER LAUNCH NO SEPARATION
NO. 5	MR-2 BALLISTIC PRIMATE MISSION	IN STORAGE AT HOUSTON, TEXAS
NO. 6	MA-2 MAX. "G", MAX. HEAT ON AFTERBODY	TURNED OVER TO PAO IN HOUSTON TO BE USED AS DISPLAY ARTICLE
NO. 7	MR-3 BALLISTIC MANNED	SMITHSONIAN INSTITUTION, WASHINGTON, D.C.
NO. 8	MA-3 UNMANNED ORBITAL - (ALL MISSION OBJECTIVES NOT ACCOMPLISHED)	
NO. 8A	MA-4 UNMANNED ORBITAL	IN STORAGE AT HOUSTON, TEXAS
NO. 9	MA-5 PRIMATE ORBITAL MISSION	
NO. 9A	PROJECT ORBIT	IN STORAGE AT HOUSTON, TEXAS
NO. 10	PROJECT ORBIT	IN STORAGE AT HOUSTON, TEXAS
NO. 11	MR-4 BALLISTIC MANNED	LOST ON RECOVERY, PREMATURE ACTUATION OF SIDE HATCH ALLOWED SHIPPING OF WATER AFTER IMPACT
NO. 12	MA-6 ALTERNATE (NOT USED FOR MISSION)	
NO. 12B	MANNED ONE DAY MISSION	IN STORAGE AT HOUSTON, TEXAS
NO. 13	MA-6 ORBITAL MANNED	SMITHSONIAN INSTITUTION, WASHINGTON, D.C.
NO. 14	LITTLE JOE 5A MAX. "Q" - (ALL MISSION OBJECTIVES NOT ACCOMPLISHED)	
NO. 14A	LITTLE JOE 5B MAX. "Q"	
NO. 14A	PROJECT REEF	IN STORAGE AT HOUSTON, TEXAS
NO. 15	MR CONFIGURATION SHIPPED TO CAPE, MISSION CANCELED	
NO. 15B	MANNED ONE DAY MISSION	IN STORAGE AT CAPE CANAVERAL
NO. 16	MA-8 MANNED 6 ORBITAL MISSION	ON U.S.I.A. TOUR IN EUROPE
NO. 17	MANNED ONE DAY MISSION	IN STORAGE AT HOUSTON, TEXAS
NO. 18	MA-7 MANNED ORBITAL MISSION	IN STORAGE AT HOUSTON, TEXAS
NO. 19	MA-9 MANNED 6 ORBITAL MISSION (BACKUP)	IN STORAGE AT HOUSTON, TEXAS
NO. 20	MANNED ONE DAY MISSION	IN PREPARATION FOR DISPLAY AT ST. LOUIS, MO.

FIGURE 1. UTILIZATION AND LOCATION OF MERCURY PRODUCTION SPACECRAFT

[redacted]

[redacted]

S C NO	USE	MISSION	DATE LAUNCHED
1	BEACH ABORT	SYSTEM QUAL TEST ESCAPE LAND G POSTLAND G UNMANNED	5-9-60
2	MR-1	BALLISTIC UNMANNED	12-19-60
3	L J-5	MERC MAX Q ABORT UNMANNED	11 8 60
4	MA 1	MAX G MAX HEAT ON AFTERBODY UNMANNED	7 29 60
5	MR-2	BALLISTIC PRIMATE	1-31-61
6	MA 2	MAX G MAX HEAT ON AFTERBODY – UNMANNED	2-21-61
7	MR-3	BALLISTIC – MANNED	5-5-61
8	MA 3	ORBITAL UNMANNED	4 25 61
8 A	MA 4	ORBITAL – UNMANNED	9-13-61
9	MA 5	ORBITAL PRIMATE	11-29 61
10	GROUND TEST	ORBITAL FLIGHT ENVIRONMENTAL TEST	COMPLETED 6-1-62
11	MR-4	BALLISTIC – MANNED	7 21 61
12 B	UNASSIGNED	ORBITAL MANNED ONE DAY MISSION	CANCELED
13	MA-6	ORBITAL MANNED	2 20 62
14	L J-5A	MERCURY MAX Q ABORT UNMANNED	3-18-61
14A	L J 5 B	MERCURY MAX Q ABORT UNMANNED	4-28-61
15 B	MA 10	ORBITAL MANNED ONE DAY MISSION	CANCELED
16	MA-8	ORBITAL MANNED	10-3-62
17	UNASSIGNED	ORBITAL MANNED ONE DAY MISSION	CANCELED
18	MA-7	ORBITAL – MANNED	5-24-62
19	UNASSIGNED	ORBITAL MANNED	CANCELED
20	MA 9	ORBITAL MANNED ONE DAY MISSION	5 15 63



NOTE: MERCURY RANGE NETWORK COMPLETELY OPERATIONAL SEPT. 13, 1962. TWO COMMAND SHIPS BEING USED FOR MANNED ONE DAY MISSIONS, ROSE KNOT VICTOR AND COASTAL SENTRY QUEBEC.

Figure 2.- PROJECT MERCURY Master planning schedule status as of 7-31-63.

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[redacted]

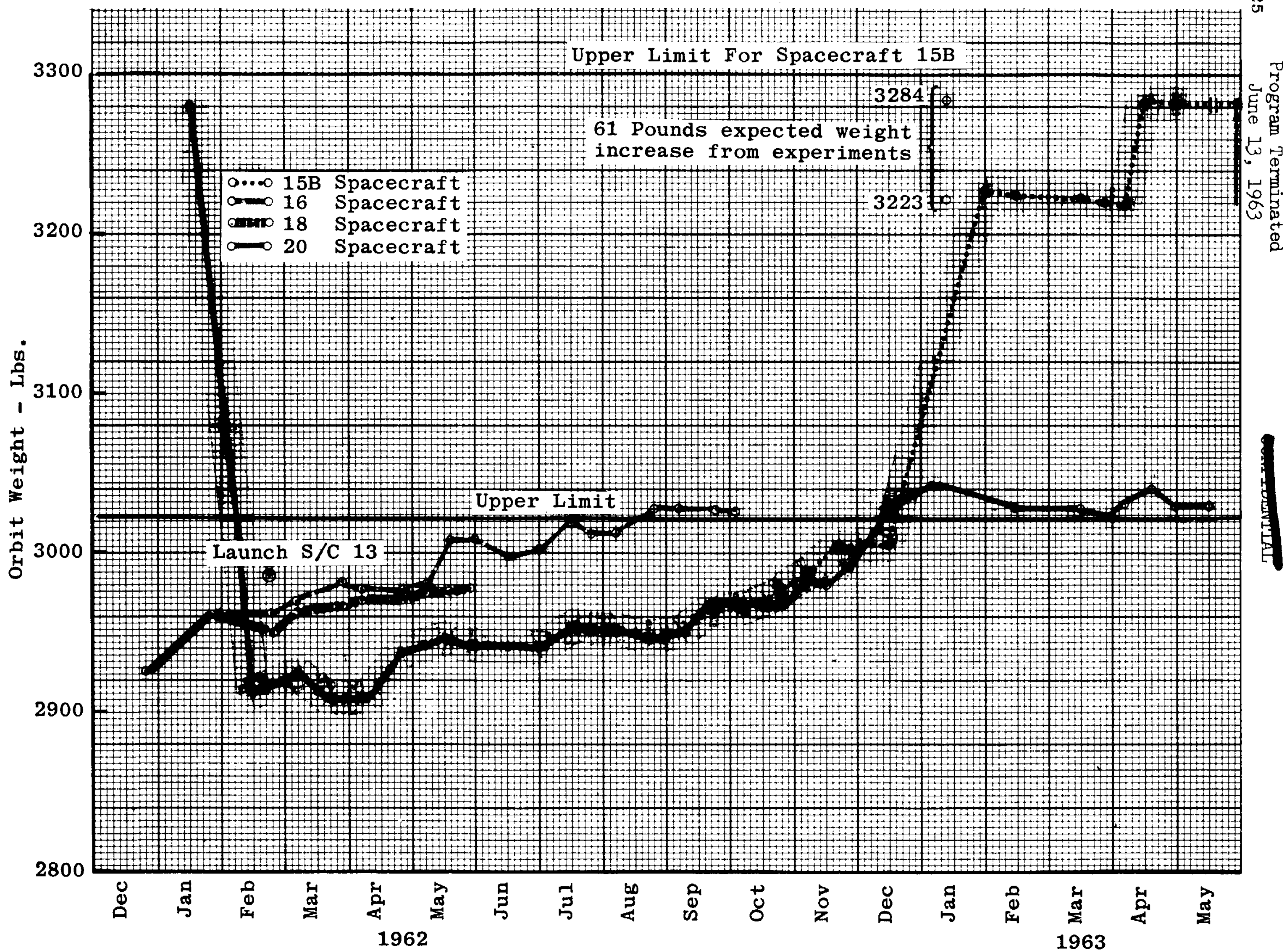

FIGURE 3 - ORBIT WEIGHT HISTORY AND TRENDS

[redacted]

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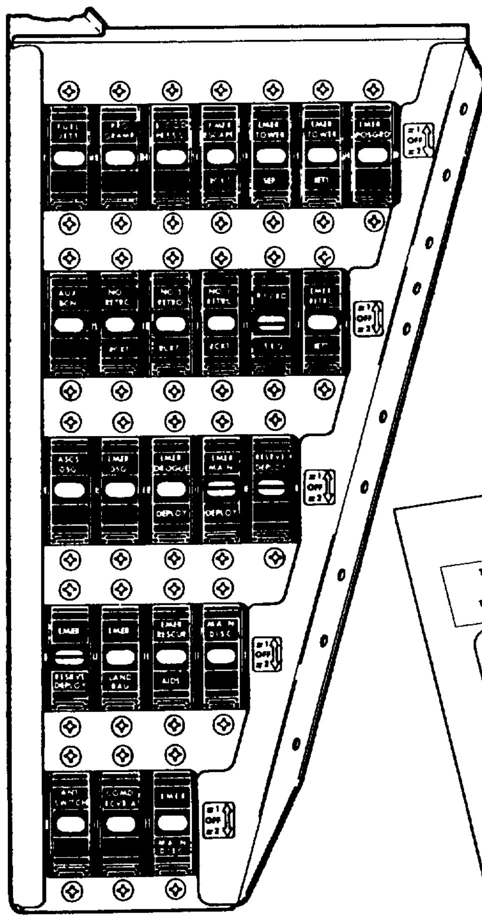
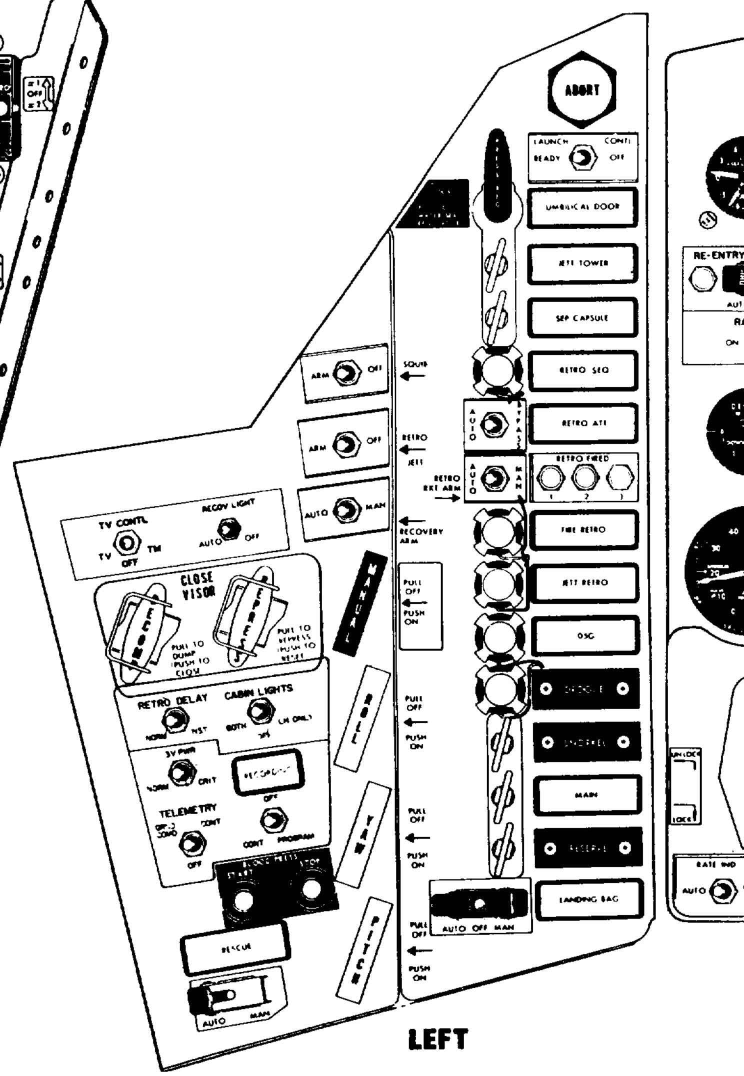
FOLDOUT FRAME

~~CONFIDENTIAL~~



BLACK BAR ON TIP OF TOGGLE HANDLE INDICATES SOLID CONDUCTOR IN THE NO. 2 POSITION. THIS INSURES POSITIVE CONTINUITY IN EVENT OF CIRCUIT MALFUNCTION.

FUSE



LEFT

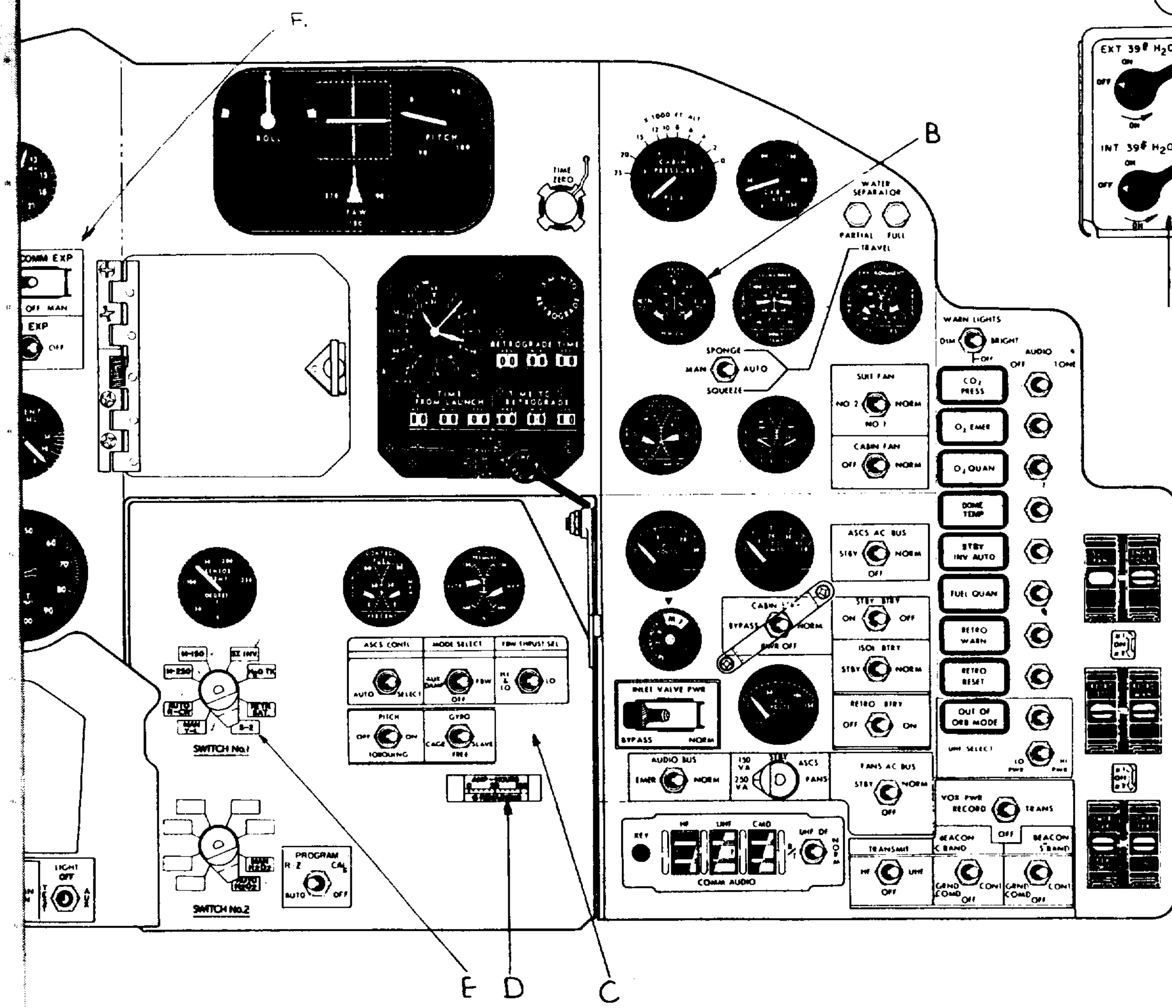
1

2

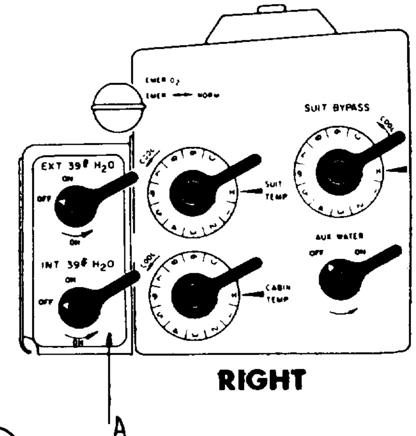
FOLDOUT FRAME

INSTRUMENT PANELS

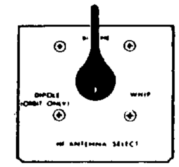
SPACECRAFT 15B



MAIN



RIGHT



MANUAL COAX SWITCH
(LOCATED BELOW R.H. CONSOLE)

FIGURE 4

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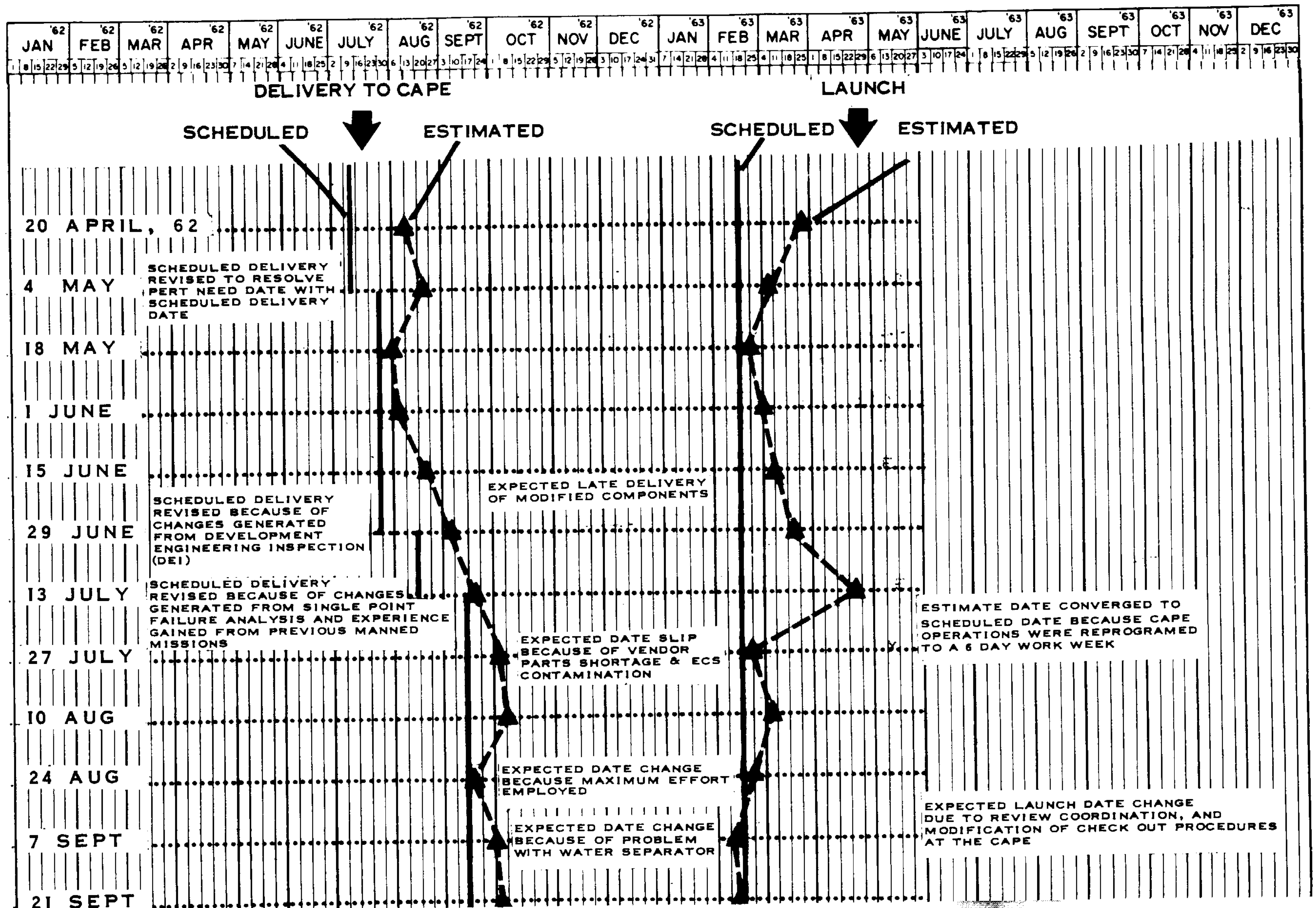

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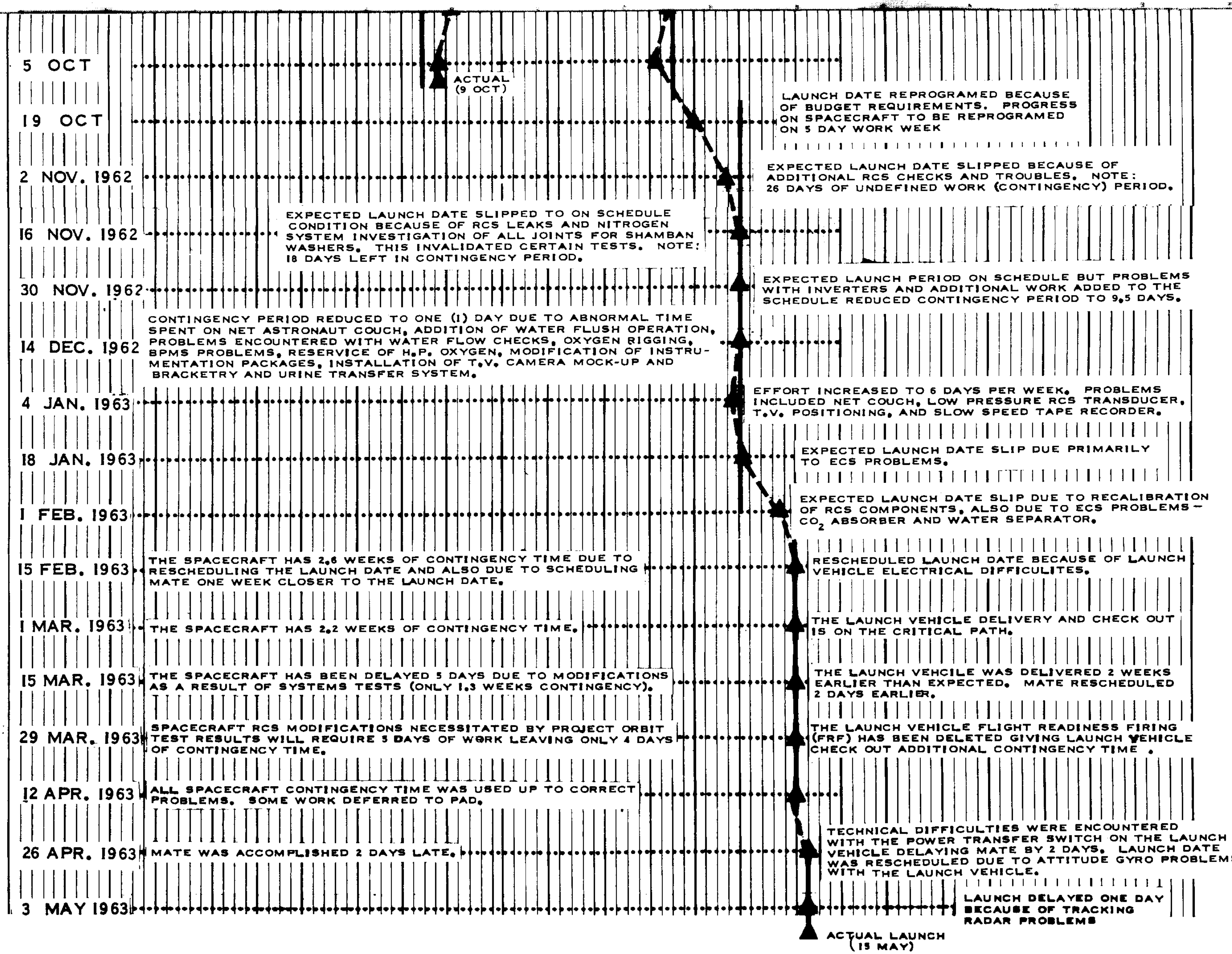
2



MA-9 MISSION PERT TREND CHART

FIGURE 5

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